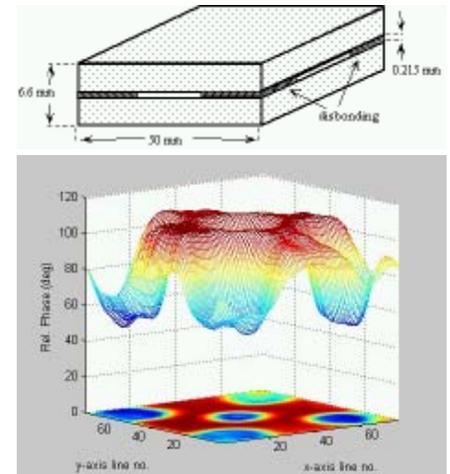
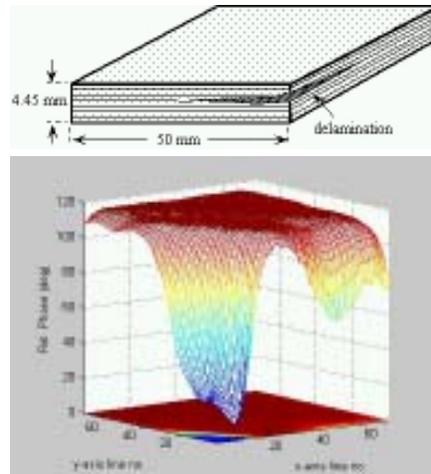


## Argonne innovations in nondestructive evaluation technologies aid many industries

Argonne National Laboratory has long-standing and extensive expertise in the nondestructive testing and evaluation of components for nuclear and fossil power plants, for automotive and military equipment, and for aircraft and the space shuttle. Argonne scientists and engineers work closely with colleagues from industry and other government laboratories to develop new techniques and assess the reliability of conventional and emerging non-destructive technologies and methods to detect defects in metals, ceramics, alloys and advanced composite materials.

A wide range of Argonne-developed technologies, including electromagnetic and acoustic methods, are used for in-service inspection of nuclear power plant components, such as tubing, piping and pressure vessels. Argonne's expertise and unique non-destructive evaluation (NDE) facilities are expected to play a leading role in developing and demonstrating inspection technologies for advanced nuclear reactors and their components.

Argonne's expertise in ceramic NDE is well established in the engineering community. The laboratory's capabilities include phased array ultrasonics, X-ray computed tomography, thermal imaging, optical coherence tomography, confocal microscopy, microwave/millimeter-wave (MW/



*SENSOR TECHNOLOGY – Microwave/Millimeter-Wave (MM/MW) sensor technology is one of many non-destructive evaluation technologies pioneered at Argonne. The technique is sensitive to both microscopic and macroscopic changes in materials. The images above show MM/MW-wave sensor results for (left) a laminate with deteriorated bonding and (right) one with disbonding.*

MMW) sensing, eddy current testing, and optical laser backscatter. Specific examples of Argonne's NDE expertise and facilities include:

- National user facilities such as the Advanced Photon Source, Intense Pulsed Neutron Source and the Electron Microscopy Center, all located on Argonne's campus, have been used for NDE of advanced ceramics.
- For optically translucent engineering materials – including such structural ceramics as  $\text{Si}_3\text{N}_4$ ,  $\text{SiC}$ ,  $\text{Al}_2\text{O}_3$  – optical coherence tomography is used to detect near-surface defects.

### Non-destructive evaluation activities at Argonne

#### Optical techniques

- Optical coherence tomography
- Elastic optical backscatter
- Polarized laser backscatter
- Confocal microscopy

#### X-ray computed tomography

#### Ultrasonic techniques

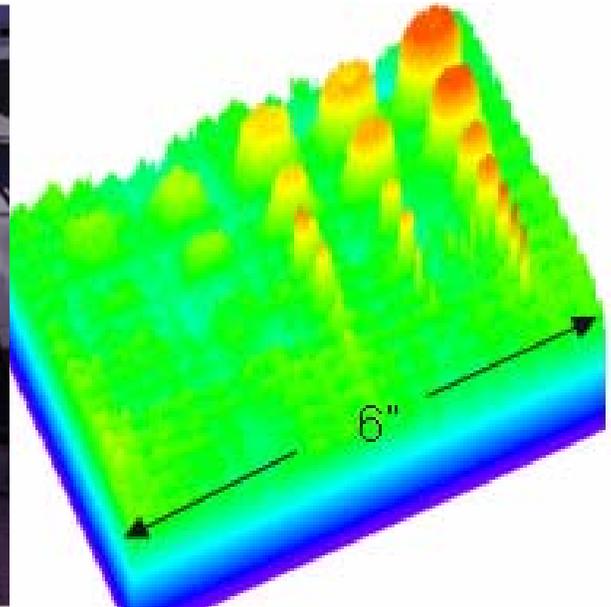
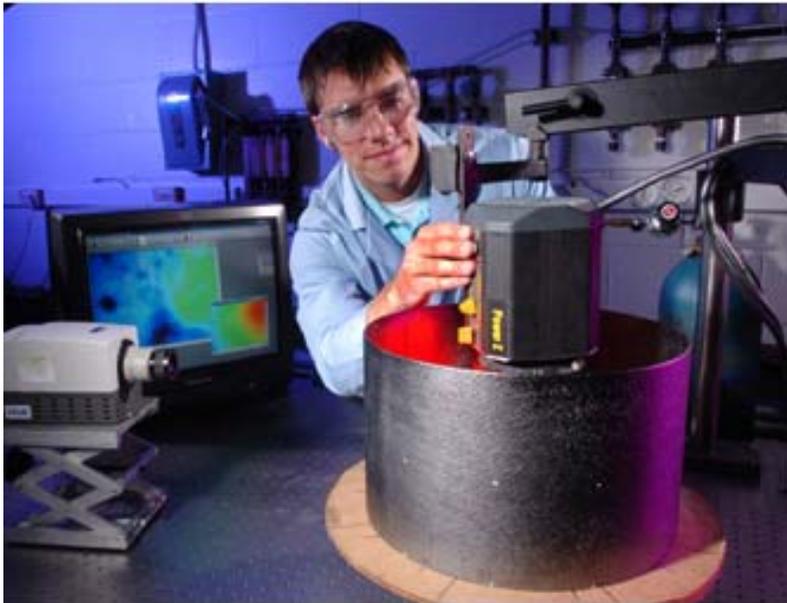
- Various conventional UT methods
- Phased array ultrasound

#### Thermal imaging techniques

- Pulsed thermal imaging
- Vibrothermography

#### EM induction and RF techniques

- Eddy current testing
- Microwave/Millimeter-wave sensing



**ADVANCED THERMAL IMAGING** – Advanced thermal imaging technologies use infrared imaging of surface temperatures to determine a material's internal properties and structure and to detect defects or damage structures.

- Advanced X-ray computed tomography techniques have been developed for high-resolution volumetric imaging of engineering materials.
- Phased array ultrasonics is used extensively for component inspection.
- Pulsed thermal imaging techniques have been developed to probe internal material properties and structure and to detect surface and subsurface defects. Pulsed thermal imaging systems can determine thermal property distribution in three dimensions, detect defects, and determine sizing. Specialized techniques are also being developed for imaging of multilayered
- Confocal microscopy and polarized laser scattering are used to detect subsurface flaws in ceramic components.
- Electromagnetic testing methods are employed to inspect conductor and semiconductor materials.
- Software tools have been developed for efficient, automated and reliable data analysis.
- Argonne is a leading research institution in the field of MW sensor technology. Both active and passive MW/MMW sensing techniques have been developed for NDE of composite materials, including ceramic components.

#### For more information

Sasan Bakhtiari  
 Nuclear Engineering Division  
 Argonne National Laboratory  
 9700 S. Cass Ave.  
 Argonne, IL 60439  
 Phone: 630-252-8982  
 Fax: 630-252-3250  
 E-mail: bakhtiari@anl.gov

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